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Research Article

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Studies on the application of human and cattle urine on soil properties and yield of vegetable crops

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Summary

The field experiment was conducted at farmer's field with the application of human and cattle urine as liquid fertilizer or nutrient sources on ashgourd [*Benincasa hispida* (Thunb.) Cong.], French bean (*Phaseolus vulgaris* L.), pole bean (*Phaseolus vulgaris* L.) and pumpkin (*Cucurbita maxima*) as test crops at Nagasandra village, Doddaballapur, Bangalore rural district from 2009 to 2011. The objective of the study was to know the effect of repeated application of human urine and cattle urine on soil properties and yield of vegetable crops. Application of recommended dose of nitrogen through human urine in three split doses plus gypsum recorded higher yield (39.2,14.2, 17.4 and 38.7 t ha^{-1}, for ashgourd, French bean, pole bean and pumpkin, respectively) and it was at par with recommended dose of nitrogen through cattle urine in three splits plus gypsum (T_{14}: 38.0, 14.1, 16.6 and 37.5 t ha^{-1}, for ashgourd, French bean, pole bean and pumpkin, respectively) and recommended dose of fertilizers (T_2: 36.7, 13.7, 15.8 and 36.8 t ha^{-1}, for ashgourd, French bean, pole bean and pumpkin, respectively). Significantly higher primary, secondary and micronutrient content in soil were recorded with recommended dose of nitrogen through human urine in three split doses plus gypsum at harvest of ashgourd crop. The trend of variation in available nitrogen, phosphorus and potassium content of soil recorded at harvest of ashgourd was retained in subsequent seasons when French bean, pole bean and pumpkin crops were grown in sequence after ashgourd crop in the same plots receiving same treatments.

Key words : Ashgourd, Pole bean, Human urine, Cattle urine, Nitrogen, Nutrients

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Introduction

The nutrients in urine are in the forms which are readily available to plants. The nitrogen is in the form of urea which readily degrades to ammonium and nitrate forms and phosphorus, potassium and sulphates are in ionic forms. This makes urine a unique biogenic fertilizer.

The strategy for production of vegetables in the present context must be by increasing the productivity of land under cultivation, reduced costs of production and higher input use efficiency with no harm to the soil, ground water, environment and product quality.

Soil-plant-environment system should be free from economic exploitation and overuse and misuse of the inputs. No doubt, the use of mineral fertilizers and pesticides was a boon in the past, but their non-judicious use is being considered a bane in the present scenario,

causing for a shift towards organic farming which has its own limitations. It is now time to reanalyse the production advantage to the cost of nature destruction, where impairment of soil physical, chemical and biological properties are the key problems associated with indiscriminate and over use of synthetic fertilizers and pesticides. The poor soil respiration rate and complete vanishing of natural decomposer communities from agro-ecosystems further threatens land sustainability and food security around the world. The judicious use of naturally available resources like human urine (anthropogenic liquid waste) and cattle urine help in maintaining yield stability through correction of marginal deficiencies of macro and micro-nutrients, enhancing efficiency of applied nutrients and providing favourable soil chemical and physical conditions and reducing the environmental pollution.

Therefore, judicious use of anthropogenic liquid waste in the areas of agriculture will increase, it must be insured that the quality and fertility of soils are not negatively affected in the long term perspective. This means in the practice that there is a need for research on efficiency and environmental impact of these nutrient sources.

Taking all these factors into consideration, the study entitled with "studies on the effect of repeated application of human urine and cattle urine on soil properties, growth and yield of vegetable crops" was taken up with the objectives of to study the effect of application of human and cattle urine on soil properties, growth and yield of vegetable crops.

Resource and Research Methods

A field experiment was conducted from 2009 - 2010 to 2010 - 2011 for the period of two successive years in the same experimental plots at Nagasandra village, Doddaballapur, Bangalore rural district as a part of Ph.D. research programme in the Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, GKVK, Bangalore. The experimental field is situated between 13° 292' North latitude and 77° 543' East longitude with an altitude of 880 meters (2890ft) above mean sea level. The soil was sandy clay loam in texture with coarse sand, fine sand, silt and clay content of 27.5, 37.3, 11.3 and 23.9 per cent, respectively. The soil was neutral in reaction (pH-7.15), low in EC (0.22 dSm^{-1}) and low organic carbon content (0.41 %). The available nitrogen (285.51 kg ha^{-1}), phosphorus (27.63 kg ha^{-1}) and potassium (312.25 kg ha^{-1}) was medium in soil.

The ashgourd (*Benincasa hispida* (Thunb.) Cong.), French bean (*Phaseolus vulgaris* L.), pole bean (*Phaseolus vulgaris* L.) and pumpkin (*Cucurbita maxima*) with the varieties of C.O.1, Arka komal, Kentuki wonder and Arka suryamukhi, respectively, were used as test crops. The experiment was laid out in a Randomized Completely Block Design replicated thrice with fourteen treatments, the gross plot size was 7.5m x 3.2m.

Out of fourteen treatments, twelve were divided into three categores based on the application of human urine and cattle urine as N sources during crop growth period *viz.*, single dose, two split doses and three split doses. The treatments, farmyard manure alone and recommended dose of fertilizer plus FYM were used as control and balance of P and K were supplied through chemical fertilizers as single super phosphate and muriate of potash, respectively.

Table A : Treatments

T_1	Farm yard manure (FYM) alone
T_2	Recommended dose of fertilizers (RDF)
T_3	RDN through human urine in single dose
T_4	RDN through human urine in single dose + gypsum
T_5	RDN through cattle urine in single dose
T_6	RDN through cattle urine in single dose + gypsum
T_7	RDN through human urine in two split doses
T_8	RDN through human urine in two split doses + gypsum
T_9	RDN through cattle urine in two split doses
T_{10}	RDN through cattle urine in two split doses + gypsum
T_{11}	RDN through human urine in three split doses
T_{12}	RDN through human urine in three split doses + gypsum
T_{13}	RDN through cattle urine in three split doses
T_{14}	RDN through cattle urine in three split doses + gypsum

where, RDN= Recommended dose of nitrogen

The chemical composition for human urine was 0.30, 0.17, 0.18 per cent, N, P_2O_5 and K_2O, respectively, for cattle urine was 0.25, 0.12 and 0.16 per cent N, P_2O_5 and K_2O, respectively and for farmyard manure was 0.45, 0.20 and 0.35 per cent, N, P_2O_5 and K_2O, respectively.

The quantity of human and cattle urine was calculated based on the nitrogen content of urine and dosage of nitrogen recommended for the crop by the university.

The total quantity of human urine/ cattle urine required per hectare to meet the recommended dose of

nitrogen (kg/ha) to different crops was calculated using formula as given below.

$$\text{Quantity of human / cattle urine } (m^3\ ha^{-1}) = \frac{\text{Recommended dose of nitrogen x 100}}{\text{Per cent total nitrogen in human / cattle urine x 1000}}$$

The calculated quantity of gypsum was applied as basal dose only in case of treatments receiving the human urine and cattle urine with gypsum as per the treatment details to overcome the effect of sodium if any on soil physical and chemical properties. The quantity of gypsum applied was 6.45 kg per cubic meter of urine, which was arrived at by considering the per cent sodium per cent in urine (an average of 0.3% Na).

The pH of the soil was determined Potentiometric method (Piper, 1966) and electrical conductivity was by Conductometry (Jackson, 1973). Determination of available nitrogen in soil was determined by alkali potassium permanganate method with the help of kjeldahl distillation unit (Subbiah and Asija, 1956), Available phosphorus content of soil was estimated by Olsen's extractant and vanadomolybdate colorimetry method (Jackson, 1973) and the potassium content was determined by neutral normal ammonium acetate ($\underline{N}$ NH_4OAc) extractant method and with a microprocessor based flame photometer (Systronics-Flamephotometer 128) (Jackson, 1973). Whereas secondary nutrients like calcium and magnesium were determined by ammonium acetate extraction and Versenate titration method (Jackson, 1973) and the available sulphur by 0.15 per cent $CaCl_2$ extractant method with Turbidometry (Black, 1965). Exchangeable sodium estimated by $\underline{N}$ NH_4OAc extractant method and with a microprocessor based flame photometer (Systronics-Flamephotometer 128) (Jackson, 1973). Di-ethaline triamine penta acitic acid (DTPA) extractable iron, manganese, zinc and copper were determined by DTPA extraction method and with the help of atomic absorption spectrophotometry (Lindsay and Norvell, 1978). Fruit yield recorded per plot was multiplied by total number of plants per hectare and was converted to hectare basis at harvest of each crop.

Research Findings and Discussion

The soil pH and electrical conductivity of soil at harvest of ashgourd crop differed significantly due to application of human urine and cattle urine on nitrogen basis with balance P_2O_5 and K_2O applied through fertilizers. In three split doses of human urine without gypsum (T_{11}:7.55 and 0.27 dS m^{-1}) which was at par with cattle urine in three split doses without gypsum (T_{13}: 7.47 and 0.26 dS m^{-1}), recommended dose of nitrogen through application of human urine in two split doses without gypsum (T_7: 7.35 and 0.26 dS m^{-1}) and application of cattle urine in two split doses without gypsum (T_9).

Table 1: Effect of split application of human urine and cattle urine with and without gypsum on pH and electrical conductivity (dS m^{-1}) of soil at harvest of different vegetable crops

Treatments	Ashgourd		French bean		Pole bean		Pumpkin	
	pH	EC	pH	EC	pH	EC	pH	EC
T_1	6.78	0.21	7.02	0.23	6.78	0.32	7.13	0.39
T_2	6.83	0.21	7.08	0.24	6.86	0.33	7.14	0.39
T_3	7.19	0.25	7.44	0.33	7.54	0.40	7.57	0.45
T_4	6.87	0.22	7.11	0.26	7.04	0.35	7.23	0.41
T_5	7.19	0.24	7.44	0.32	7.46	0.39	7.57	0.44
T_6	6.84	0.22	7.08	0.25	6.95	0.34	7.20	0.40
T_7	7.35	0.26	7.61	0.34	7.72	0.42	7.73	0.46
T_8	7.03	0.23	7.28	0.29	7.27	0.37	7.40	0.42
T_9	7.24	0.25	7.50	0.34	7.63	0.41	7.62	0.46
T_{10}	6.92	0.23	7.17	0.28	7.12	0.36	7.29	0.41
T_{11}	7.55	0.27	7.81	0.35	8.04	0.44	7.94	0.48
T_{12}	7.13	0.24	7.38	0.31	7.37	0.39	7.50	0.44
T_{13}	7.47	0.26	7.74	0.34	8.06	0.43	7.87	0.47
T_{14}	7.06	0.24	7.31	0.30	7.29	0.38	7.43	0.43
S.E. $\pm$	0.15	0.01	0.15	0.01	0.17	0.01	0.15	0.01
C.D.(P=0.05)	0.43	0.02	0.45	0.04	0.49	0.04	0.45	0.03

Similar trend was observed at harvest of French bean, pole bean and pumpkin crops which were grown sequentially in the subsequent seasons or year in the same plot where ashgourd crop grown (Table 1).

The slight increase in soil pH and electrical conductivity by application of human/ cattle urine was restricted to treatment without gypsum application was observed. Whereas, the original soil pH and electrical conductivity was not much affected in treatments with gypsum. Therefore, a slight increase in pH was observed at harvest of French bean (7.81), pole bean (8.04) and pumpkin (7.94) crops with treatment involving application of human urine in three split doses without gypsum (T_{11}) compared to other treatments.

The increase in pH may be due to addition of substantial amount of calcium, magnesium, bicarbonates and even sodium through human urine and cattle urine application. Similar increase in pH of soil with application of anthopogenic liquid waste were reported by Mnkeni *et al*. (2006) and Vinneras *et al*. (2006). The decomposition of urea will lead to an increase in the concentration of ammonium and an increase in pH in urine (Rodhe *et al.,* 2004). Slight increase in electrical conductivity is attributed to the presence of high salt content in urine, which upon application to soil has enhanced the EC. However, the salt content after the harvest of the crop was below the threshold level (0.8 dS m^{-1}). The results are in accordance with Mnkeni and Austin (2009). Jonsson *et al*. (2004) opined that though the salt concentration is quite high in urine.

Available N, P_2O_5, K_2O (kg ha^{-1}) in soil :

The available nitrogen, phosphorus and potassium contents of soil at harvest of ashgourd crop varied significantly due to application of human urine and cattle urine and was highest in treatment receiving recommended dose of nitrogen through human urine in three split doses plus gypsum (T_{12}: 290.9, 31.4 and 319.9 kg N, P_2O_5 and K_2O ha^{-1}, respectively) and which were at par with T_{14}, T_2, T_{11} and T_{13} treatments. Similar results were observed at harvest of French bean, pole bean and pumpkin crops which were grown sequentially in the subsequent seasons in the same plot where ashgourd crop was grown during the year 2009-10 and 2010-11. The trend of variation in available nitrogen, phosphorus and potassium contents of soil recorded at harvest of ashgourd was retained in subsequent seasons when French bean (T_{12}: 291.3, 32.3 and 324.2 kg N, P_2O_5 and K_2O ha^{-1}, respectively), pole bean (T_{12}: 298.2, 31.8 and 323.7 kg N, P_2O_5 and K_2O ha^{-1}, respectively) and pumpkin (T_{12}: 302.2, 31.9 and 330.9 kg N, P_2O_5 and K_2O ha^{-1}, respectively) crops were grown in sequence after

Table 2: Effect of split application of human urine and cattle urine with and without gypsum on available nitrogen, phosphorus and potassium (kg ha^{-1}) content of soil at harvest of vegetable crops

Treatments	Ashgourd			French bean			Pole bean			Pumpkin		
	Avail. N	Avail. P_2O_5	Avail. K_2O	Avail. N	Avail. P_2O_5	Avail. K_2O	Avail. N	Avail. P_2O_5	Avail. K_2O	Avail. N	Avail. P_2O_5	Avail. K_2O
T_1	269.6	25.3	274.0	266.5	24.45	265.9	256.2	23.3	259.0	261.0	22.9	257.2
T_2	288.0	30.1	316.2	285.5	30.62	314.5	289.9	30.0	314.3	292.5	30.0	317.9
T_3	272.7	26.7	277.4	270.6	26.24	283.4	264.1	25.2	278.0	265.6	24.9	274.9
T_4	273.4	27.4	284.3	270.6	27.19	293.1	267.5	26.3	288.6	269.3	26.0	286.2
T_5	271.8	26.3	275.7	267.8	25.78	279.0	259.7	24.8	273.2	264.4	24.4	269.8
T_6	273.2	27.1	280.6	275.4	26.71	288.2	265.2	25.8	283.3	266.6	25.5	280.5
T_7	275.1	28.2	291.0	277.0	28.17	296.5	273.2	27.4	299.2	276.2	27.2	297.5
T_8	276.8	28.9	303.1	278.0	29.10	297.0	274.1	28.4	306.2	281.8	28.2	299.4
T_9	273.6	27.8	284.9	276.1	27.70	293.6	268.8	26.8	294.0	271.5	26.6	292.0
T_{10}	275.4	28.6	297.8	277.0	28.65	296.9	273.9	27.9	304.4	279.4	27.7	298.8
T_{11}	283.6	29.4	313.8	282.7	29.72	306.5	281.1	29.1	313.7	289.0	29.0	315.5
T_{12}	290.9	31.4	319.9	291.3	32.29	324.2	298.2	31.8	323.7	302.2	31.9	330.9
T_{13}	281.0	29.3	310.2	281.0	29.63	300.3	280.1	28.9	309.9	286.7	28.9	314.3
T_{14}	287.0	30.5	317.8	288.4	31.09	321.0	294.0	30.6	320.3	295.6	30.6	324.3
S.E. $\pm$	3.0	0.8	5.7	3.0	0.97	8.8	7.9	1.0	5.8	5.3	1.1	10.4
C.D.(P=0.05)	8.8	2.2	16.5	8.6	2.83	25.7	23.0	3.0	16.8	15.5	3.1	30.3

ashgourd crop in the same plots receiving same treatments (Table 2). Vinneras *et al.* (2003) found that the plant nutrients in both anthropogenic liquid waste and faeces emanate from arable fields and thus should be recycled as fertilizers to support sustainability and to retain the fertility of the fields. Anthropogenic liquid waste becomes a quick acting fertilizer rich in nitrogen and with a composition of nutrients that well matches the needs of many crops. The enhancement in phosphorus availability was due to the combined effect of released organic acids and organic anions on the decomposition of organic matter as a result of improving biological properties of soil and reduction in the activity of phosphorus complexing agent to make phosphorus available to the crop. Similar results were also reported by Vinneras (2001). Human urine and cattle urine application based on the N requirement of vegetable crops along with this also added K to soil. This is due to the fact that, urine had substantial amount of K and is mostly in ionic form and becomes immediately available to the plants. The results are in conformity with the findings of Cardlander *et al*. (2001) and Hellstrom *et al*. (1999).

Secondary nutrients in soil :

Significantly higher exchangeable calcium, magnesium and available sulphur in soil were recorded in treatment receiving recommended dose of nitrogen through human urine in three split doses plus gypsum (T_{12}: 4.87 and 2.83 cmol (p^+) kg^{-1} and 14.0 kg ha^{-1}, respectively) and it was at par with T_{14}, T_8, T_{10}, T_4 and T_6 (Table 3). This might be due to the presence of appreciable quantities of Ca, Mg and S in urine which upon application to soil increased the Ca, Mg and S content (Altman and Dittmer, 1994).

Whereas the exchangeable sodium differed significantly higher at harvest of ashgourd with application of human urine in three split doses without gypsum (T_{11}: 0.26 cmol (p^+) kg^{-1}) which was at par with cattle urine in three split doses without gypsum. And similar results were observed at harvest of French bean, pole bean and pumpkin crops which were grown sequentially in the subsequent seasons in the same plot where ashgourd crop was grown (Table 3).

Repeated application of human urine in three split doses without gypsum (T_{11}: 0.29, 0.37 and 0.51 cmol (p^+) kg^{-1}, respectively) recorded slight increase in the exchangeable sodium content of soil after the harvest of French bean, pole bean and pumpkin crops followed by T_{13}, T_7, T_9, T_3 and T_5. Lower exchangeable sodium content of soil was recorded in treatment receiving farmyard manure alone (T_1) followed by T_2, T_4, T_6, T_8 and T_{10} treatments.

This kind of result was attributed due to the presence

Table 3: Effect of split application of human urine and cattle urine with and without gypsum on exchangeable calcium, magnesium, sodium [cmol (p+) kg^{-1}] and available sulphur (kg ha^{-1}) content of soil after harvest of vegetable crops

Treatments	Ashgourd				French bean				Pole bean				Pumpkin			
	Exch. Ca	Exch. Mg	Exch. Na	Avial. S	Exch. Ca	Exch. Mg	Exch. Na	Avial. S	Exch. Ca	Exch. Mg	Exch. Na	Avial. S	Exch. Ca	Exch. Mg	Exch. Na	Avial. S
T_1	3.38	1.99	0.15	9.9	3.88	2.22	0.21	10.05	3.07	2.09	0.20	10.28	3.18	2.38	0.32	18.4
T_2	4.18	2.44	0.16	12.1	4.95	2.47	0.22	12.43	4.30	2.72	0.22	13.33	4.37	3.00	0.34	22.8
T_3	3.59	2.12	0.23	10.7	4.10	2.29	0.27	11.52	3.39	2.55	0.32	10.89	4.04	2.55	0.45	19.6
T_4	4.42	2.57	0.16	12.8	5.25	2.55	0.23	13.13	4.68	2.90	0.23	14.28	4.70	3.18	0.35	24.1
T_5	3.47	2.06	0.22	10.2	4.04	2.26	0.26	10.31	3.21	2.19	0.31	10.41	3.36	2.47	0.44	18.9
T_6	4.30	2.51	0.17	12.4	5.10	2.51	0.23	12.77	4.47	2.81	0.24	13.84	4.53	3.09	0.36	23.4
T_7	3.82	2.25	0.25	11.1	4.48	2.37	0.28	11.34	3.74	2.44	0.35	11.86	3.84	2.73	0.48	20.8
T_8	4.62	2.70	0.19	13.4	5.55	2.62	0.24	13.73	4.97	3.07	0.27	15.29	5.03	3.35	0.39	25.2
T_9	3.69	2.19	0.23	10.8	4.34	2.33	0.27	10.96	3.54	2.36	0.33	11.38	3.69	2.64	0.46	20.1
T_{10}	4.52	2.63	0.18	13.1	5.40	2.58	0.24	13.44	4.82	2.98	0.26	14.78	4.85	3.26	0.38	24.6
T_{11}	4.03	2.38	0.26	11.8	4.80	2.44	0.29	11.99	4.07	2.63	0.37	12.84	4.20	2.91	0.51	22.0
T_{12}	4.87	2.83	0.21	14.0	5.85	2.69	0.25	14.47	5.35	3.25	0.29	16.25	5.36	3.52	0.42	26.5
T_{13}	3.95	2.32	0.25	11.5	4.65	2.40	0.28	11.72	3.93	2.54	0.36	12.36	4.03	2.82	0.50	21.5
T_{14}	4.78	2.76	0.20	13.7	5.72	2.65	0.25	14.19	5.20	3.17	0.28	15.77	5.21	3.44	0.41	26.0
S.E. ±	0.22	0.12	0.02	0.6	0.27	0.24	0.01	0.61	0.33	0.16	0.02	0.89	0.29	0.16	0.03	1.2
C.D.(P=0.05)	0.63	0.34	0.05	1.6	0.78	0.71	0.03	1.78	0.96	0.48	0.07	2.59	0.85	0.46	0.08	3.4

of appreciable quantities of sodum in urine which upon application to soil increases the sodium content in soil (Kirchmann and Pettersson, 1995).

DTPA extractable micronutrient (mg kg^{-1}) :

The DTPA extractable iron, manganese, zinc and copper content of soil after the harvest of ashgourd crop varied significantly due to human urine and cattle urine and was highest in treatment receiving recommended dose of nitrogen through human urine in three split doses plus gypsum (T_{12}: 15.48, 10.44, 2.11 and 1.09 mg kg^{-1}) and it was at par with T_{14}, T_2, T_{11} and T_{13}. Continuous

Table 4: Effect of split application of human urine and cattle urine with and without gypsum on DTPA extractable micronutrients (mg kg^{-1}) content of soil at harvest of different vegetable crops

Treatments	Ashgourd				French bean				Pole bean				Pumpkin			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
T_1	11.89	8.15	1.16	1.32	13.25	8.97	1.41	1.15	13.11	9.59	1.47	1.43	14.96	9.68	1.56	1.40
T_2	14.94	10.13	1.97	1.88	21.79	12.50	1.87	1.86	18.75	13.50	2.20	1.72	19.09	15.31	2.51	1.95
T_3	12.44	8.75	1.30	1.42	14.03	9.46	1.49	1.28	14.32	10.30	1.49	1.48	15.71	10.45	1.72	1.49
T_4	13.00	9.06	1.43	1.53	15.45	10.13	1.56	1.40	15.25	11.02	1.66	1.53	16.46	11.56	1.88	1.59
T_5	12.16	8.60	1.21	1.37	13.43	9.12	1.44	1.21	13.59	9.94	1.49	1.43	15.34	9.89	1.63	1.44
T_6	12.72	8.90	1.36	1.47	14.75	11.13	1.51	1.34	14.83	10.66	1.57	1.51	16.10	11.00	1.78	1.54
T_7	13.55	9.36	1.58	1.62	16.84	10.82	1.65	1.53	16.44	11.72	1.80	1.58	17.21	12.56	2.07	1.70
T_8	13.97	9.59	1.68	1.73	17.97	11.23	1.72	1.66	17.37	12.43	1.93	1.63	17.90	13.42	2.18	1.79
T_9	13.27	9.22	1.51	1.58	16.21	10.48	1.60	1.47	15.99	11.35	1.74	1.56	16.84	12.12	1.96	1.65
T_{10}	13.83	9.52	1.65	1.71	17.61	11.15	1.69	1.60	16.92	12.08	1.90	1.61	17.59	13.21	2.15	1.75
T_{11}	14.65	9.99	1.88	1.83	19.73	12.17	1.80	1.79	18.27	13.13	2.15	1.69	18.71	14.96	2.43	1.90
T_{12}	15.48	10.44	2.11	1.99	21.79	13.18	1.94	1.99	19.66	14.21	2.38	1.77	19.82	16.51	2.67	2.05
T_{13}	14.38	9.83	1.79	1.78	18.85	11.82	1.77	1.73	17.80	12.78	2.05	1.67	18.34	14.28	2.32	1.84
T_{14}	15.21	10.29	2.13	1.93	21.35	12.84	1.89	1.92	19.21	13.85	2.33	1.74	19.45	16.17	2.59	1.99
S.E.±	0.54	0.26	0.13	0.08	1.00	0.61	0.06	0.10	0.63	0.60	0.08	0.05	0.64	0.70	0.13	0.07
C.D.(P=0.05)	1.58	0.76	0.39	0.23	2.90	1.76	0.18	0.29	1.82	1.76	0.24	0.14	1.85	2.05	0.37	0.21

Table 5 : Effect of split application of human urine and cattle urine with and without gypsum on vegetable yield (t ha^{-1}) and ashgourd equivalent yield (t ha^{-1}) for different vegetable crops

Treatments	Ashgourd	French bean		Pole bean		Pumpkin	
	Actual yield	Actual yield	Ashgourd equivalent yield	Actual yield	Ashgourd equivalent yield	Actual yield	Ashgourd equivalent yield
T_1	19.7	8.7	24.7	9.2	24.5	19.5	22.8
T_2	36.7	13.7	38.8	15.8	42.1	36.8	42.9
T_3	22.2	9.3	26.4	10.2	27.2	21.9	25.6
T_4	23.6	9.9	28.1	11.1	29.6	23.3	27.2
T_5	21.1	8.9	25.2	9.8	26.1	20.8	24.3
T_6	23.5	9.6	27.2	10.7	28.5	23.3	27.2
T_7	29.0	10.3	29.2	11.9	31.7	28.6	33.4
T_8	31.8	11.3	32.0	13.9	37.1	31.4	36.6
T_9	27.8	10.1	28.6	11.5	30.7	27.5	32.1
T_{10}	30.2	10.7	30.3	12.8	34.1	29.9	34.9
T_{11}	36.5	13.5	38.3	15.5	41.3	36.0	42.0
T_{12}	39.2	14.2	40.2	17.4	46.4	38.7	45.2
T_{13}	35.4	13.5	38.3	15.1	40.3	35.0	40.8
T_{14}	38.0	14.1	40.0	16.6	44.3	37.5	43.8
S.E. ±	2.01	0.4		0.76		2.02	
C.D.(P=0.05)	5.8	1.3		2.22		5.9	
C.V.	8.5	6.9		10.18		11.9	

application of human urine in three split doses plus gypsum (T_{12}) recorded slight variation in the DTPA extractable iron manganese, zinc and copper content of soil after the harvest of French bean, pole bean and pumpkin crops followed by T_{14}, T_2, T_{11} and T_{13} (Table 4). This might be due to higher solubility, diffusion and mobility of the applied micronutrients through human and cattle urine. Similar findings were reported by Palmquist and Jonsson (2003).

Yield (t ha^{-1}) :

Increased yield due to application of recommended dose of N through human urine in three split doses plus gypsum could also be attributed to the significant improvement in yield parameters like number of fruits plant^{-1} (2.1, 12.4, 94.1 and 4.7), fruit length (23.7, 15.8, 19.0 and 14.2 cm), fruit diameter (17.5 and 13.5 cm, for ashgourd and pumpkin crops, respectively) and fresh weight of fruit (4510, 7.5, 11.6 and 863.6 g) of ashgourd, French bean, pole bean and pumpkin crops, respectively (Table 5).

Higher yield recorded with recommended dose of N through human urine in three split doses plus gypsum was attributed to better root development and higher availability of nutrients to the crops. These results are in agreement with the findings of Peter Morgan (2004) and Prajapati and Gajurel (2003).

Hellstrom (1999) observed that application of human liquid waste significantly increased the yield of winter wheat over the control and artificial fertilizer treatment. Imke and Hermann (1998) reported that the concentration of plant nutrients in human urine was compared with those of liquid cattle excretion as traditional organic fertilizer. Nearly all investigated chemical parameters showed great differences.

The slight increase in soil pH and EC by application of human or cattle urine was restricted to treatment without gypsum application, whereas, the original soil pH was not much affected in treatments with gypsum.

Yield of ashgourd, French bean, pole bean and pumpkin crops recorded was significantly higher with application of recommended dose of N through human urine in three split doses plus gypsum (T_{12}: 39.2, 14.2, 17.4 and 38.7 t ha^{-1}) followed by recommended dose of N through cattle urine in three split doses plus gypsum (T_{14}) and application of recommended dose of fertilizer plus farmyard manure (T_2).

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